Deep Immersion with Kasina

An exploration of Meditation and Concentration within Virtual Reality Environments

Dr. Ralph Moseley
School of Science & Technology
Middlesex University
London, UK
r.moseley@mdx.ac.uk

***Abstract*— The matching of established meditation techniques and new technologies offer intriguing possibilities for exploring how particular states of mind can be enhanced and become an inducible target. The Kasina method of developing meditation skills can be utilized for exploring and enhancing such states within VR. A comparison of various techniques is involved, together with virtual immersion, entrainment and biofeedback through EEG, also known here as Deep Immersion.**

Keywords— Virtual Reality (VR), Deep Immersion, meditation, entrainment, auditory / visual stimuli

I. INTRODUCTION

There are many techniques for developing meditation skills, some of which have been around for millennia. These range from basic trance induction through to more complex visualisation and prop usage.

This paper follows on from previous work using VR/Merged Reality and brainwave entrainment, developed in a paper [1] and a book chapter [2]. Where the prior work explored the basis of the technique behind brain entrainment (and also, various meditation techniques with background information on each) this paper engages one particular type of meditation, building a software tool and hardware technology allowing exploration within a virtual setting.

II. KASINA

A. Description

Meditation can be approached in several ways. The techniques can roughly be broken down into using an object or not, as a means of focus [3]. The breath, for example, can be seen as an object on which to focus upon, another means is the use of Kasina [4][5]. It should be noted here that although there are many techniques the end point is said to be the same, at least within the ancient traditional texts. From a scientific perspective, there are actually quite radically different EEG "signatures" for the types of meditation. Kasina meditation is a Buddhist technique mentioned and explained in the Visuddimagga scriptures attributed to Buddhaghosa [6]. These particular scriptures influenced several other traditions and the development of techniques outside of Theravada Buddhism to which it primarily belonged. For example, it is similar in structure and technique to other traditions which have a concentration-based meditation such as yogic traditions that include samatha, dhyana or jnana.

There are many types of meditation technique and what works for one individual at one point in their life may not work for another. Usually, it is the teacher that determines which specific technique will be most suitable. Kasina is particularly useful for experimentation. The Visuddimaggi text does describe in some detail how an individual may know if the Kasina technique is right for them and this is worth relating here. An example was how an individual gazing at a display of flowers noticed that a particular colour stood out as vastly more apparent than the others, even when they closed their eyes and observed the residual retina and/or mental component. For some, it is simply gazing at a candle or into space and noticing that it suddenly became visually different.

Kasina actually means an "an object that represents a pure concept, the essence of all things which have that quality", much like some archetypal or conceptual form[1].

The main purpose of Kasina is to develop the ability to form a stable foundation of mind which can be held in its focus and thus develop the required sustained concentration. Further practices can then be developed on top of this, once stability is established.

A note should be added here, that the tool developed here is different to the commercially available mind machine named Kasina [7]. As mentioned in the previous papers this device utilises both visual and auditory brain entrainment to induce particular states through a simple Ganzfeld effect [8] headset and headphones, as opposed to the virtual environment explored here. The main difference being, in the sense of technique, that there is no visual object other than the flashing lights (and the mandala effect which sometimes accompanies

[1] In this paper the technique will be referred to with a capital 'K' and the items for concentration, also known as kasina with a lower case 'k'.

it) on which to concentrate and form a mental concentration as such. It is, rather, a passive mechanism and not true to the original technique; though the mechanism used is effective.

An interesting aside to note here is that this device is a step up from previous mind machines such as Procyon, Proteus and others [9], in that it has the ability to involve sample playing rather simple synthesis techniques of sound. It also has a greater range of colour spectrum available via its LED array within the headset.

The technique used within the virtual Kasina environment here, mimics more closely the actual original intent behind the texts.

B. The Technique

The Kasina meditation technique [10] develops the ability of the individual to concentrate deeply and for extended periods. Within Buddhism, this concentration is later used as an investigative tool [11].

Initial techniques use purely physical objects for concentration before moving to mental creations or replica of physical objects. There is a scheme of objects that are moved through as the technique is engaged and there is a classification of suitable to unsuitable items to focus upon. These are based upon elemental and colour schemes: earth (paṭhavī kasiṇa), water (āpo kasiṇa), fire (tejo kasiṇa), air, wind (vāyo kasiṇa), blue, green (nīla kasiṇa), yellow (pīta kasiṇa), red (lohita kasiṇa), white (odāta kasiṇa), enclosed space, hole, aperture (ākāsa kasiṇa), consciousness (viññāṇa kasiṇa) in the Pali suttas and some other texts; bright light (āloka kasiṇa) according to later sources, already mentioned, such as the Visuddhimagga.

These targets of meditation and focus are known as kasina and are disks with appropriate properties ascribed to them. Traditionally, each disk was approximately nine inches in diameter, made of earth with colour added.

The earth kasina, is a disk in a red-brown color formed by spreading earth or clay (or another medium producing similar color and texture) on a screen of canvas or another backing material. As stated before, the central idea behind the kasina is that each contains the purest property of that particular attribute. The blue kasina, for example, containing the quality which is common to all blue objects and all shades are represented in this perception of blueness. The understanding here is that the mind will react in whatever way it would normally to a kasina with the appropriate quality, in this case, blueness.

Each element and kasina has specific properties which may be suitable for a particular individual. For example, fire is very dynamic, transient and very similar to the mind itself at the beginning of such practices.

Following the kasina mentioned above we can describe how this would be done in a normal practice. The colours mentioned, blue, yellow, red and white can be simply coloured pieces of card cut to the size of a dinner plate. The elements mentioned require a little more effort. Earth is represented through a clay disk (perhaps a pizza stone, for example). Water is simply a bowl of water. Light, is usually a beam of light focused on an area of floor or wall space. Fire can be represented through a candle or glass faced stove. Wind and space are slightly more abstract, being quality of no-content or airiness and are usually practiced outside.

Practicing involves taking a seated position, either on a chair or on the ground; the important thing here for the student of the technique is to avoid strain on the body (in particular, the neck). The distance away from the object of meditation is also important and should be close enough to focus firmly upon it.

For the beginner, once at this point, the individual would repeat the main appropriate characteristic while focusing upon it. For example, "water, water, water …". Repetition like this helps avoid the distractions originating from the mind. The technique here calls for a relaxed focus rather than one which involves strain on the eyes or body, as it should be easily be maintainable as a posture for some time. Some points are observed from the techniques involved here:

1. A single meditation should be selected and once chosen should be adhered to, rather than jumping from object to object.
2. The idea is not to "become one with the object", which is said to lead only to a deadened state. The objects are used to gain a high degree of concentration, filling your experiential world with the qualities that the particular kasina represents. This is different to becoming absorbed in the kasina as the practitioner still perceives the external and internal universe.
3. The meditation object, in this case the kasina, is a stepping stone or similar to the lower stage booster of a rocket which takes it so far and then is jettisoned. It is simply to build the skill required for the next stage in development.

The process begins with the meditator focusing on the object and bringing to mind its qualities. Concentration is developed. In traditional practice this stage ends when the meditator can shut the eyes and bring to mind the object in full detail as clear as when the eyes are open.

A description of the initial process follows: When the initial sign arises, this is usually a symbol which is somewhat unstable. If this is maintained and practiced, so the concentration can be held on the object mentally, the vivid image is called the "learning sign" (Uggaha-nimitta) containing the apparent flaws of the kasina itself appears, after this, a counterpart sign (Patibhaga-nimitta) is said to be next to appear which is an indication of the entrance into the first of the levels of absorptions (jnana). Many of these states exist.

Within Buddhist scriptures it is described that a subtle counterpart image (similar to an after image) will eventually arise from this concentration (and absorption into the practice) which then becomes the object of attention rather than its physical component. Initially the mind is errant and unstable but after some time will become more steady upon this mental object. The meditator must remain passive and not mentally intervene to make this "happen" or manipulate any mental and/or optical image that arises. The image could be a symbol or picture.

There are differences between the learning sign and the counterpart sign. In the learning sign faults in the kasina are apparent but the counterpart appears as if breaking out from the learning sign. The counterpart is in essence a much more purified form of the original kasina.

III. THE TECHNOLOGIES USED

The development environment was placed on Apple Mac hardware and consisted of Unity [12] and Blender [13] software.

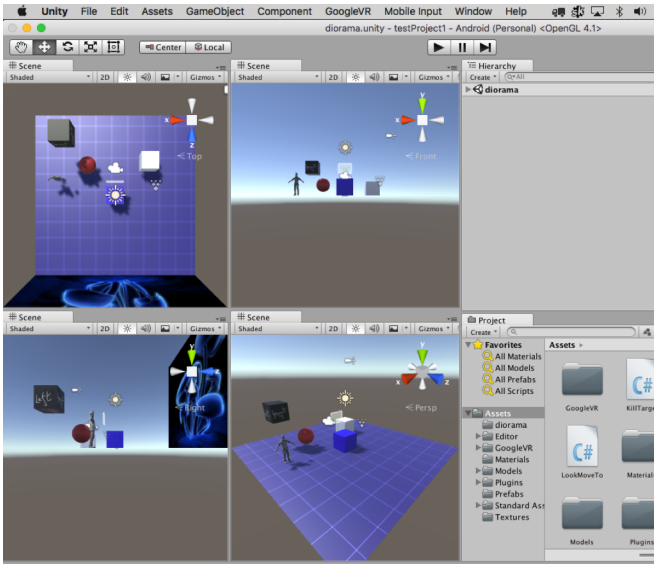

Fig. 1. The Unity environment for 3D VR development

The main headset involved was Google cardboard [14], though it is an easy matter to target other headsets and hardware within Unity. Both audio and visual systems were required – audio was used to experiment with frequency entrainment and auditory cues.

A. The Approach

Several approaches were considered and will be outlined here:

- Following the "standard" Kasina technique
- Adding properties to objects within Kasina
- Add auditory frequency look
- Add auditory and visual frequency entrainment
- Voice over

The first approach follows the Buddhist technique closely, as outlined above. This can be mimicked exactly, with the possible advantage of excluding other stimulus external to the practice itself with the immersion of the VR. A slight disadvantage may be that the equipment itself becomes a distraction, for example, the headset and EEG band creating either extra weight on the head or pressure. This is rather minimal with the latest headsets and equipment which tend to be less of a problem than previous versions which weighed a considerable amount, especially after a extended period of time. The idea is that this particular experiment is to copy the exact technique within the virtual domain as accurately as possible, though there are capabilities and advantages available to being able to manipulate the meditation area which will be explored later.

The disks used in the meditation are easy enough to replicate within VR, being just coloured and suspended circular objects. A texture of clay or something approaching it can be used for the element of the earth, formed into a disk shape. Water texture can be used to create an ovoid sphere, again suspended in the field of vision of the meditator. The light kasina can be simply a beam of focused light, using particle programming [15]. Fire can be represented again by particle programming and shaped possibly into a suspended fireball to capture the energy implied within this artefact. Two other kasina exist which are slightly more abstract to represent in the virtual environment. These are air (or wind) and space. Ordinarily, the air kasina is captured by the individual being outside by concentrating on the breeze or visible manifestations such as the waving leaves and branches in a tree. In our virtual scenario a similar representation is required this could be through particle textures in the form of a whirlwind or the reproduction of an object being effected by

the air, as in the tree. The benefit of the virtual environment does allow for more complex objects to be developed, as long as they capture the original intent behind the kasina.

Space is described as "absence contained" in the texts – that is, the hole-in-the-wall, the keyhole or the window opening. There are, of course, deeper meanings – the capturing of the space which contains everything as described in numerous Buddhist and Hindu philosophical treatise. Here, there are several options for representation. A single object could be used which contains the void, as mentioned – a keyhole, window or door. An abstract representation could be created which would not normally be possible to model in real-life (RL) space – a sphere containing nothing, a black hole or void.

B. Extending into the Virtual

As the manipulation of virtual components allows for more elaborate scenarios than simple disks, it was considered feasible to create objects which capture interesting properties of the analogous object. For example, the element of fire can be captured using particle techniques with VR, water can be made to create fluid-like 3D objects not normally possible. It is also possible to add audio properties hard to replicate within a RL space for meditation.

A more complex arrangement could be made. For example, the simple object itself could morph between aspects of the kasina. It may be interesting, though not pursued here, to create entire 'micro scenes' relevant to each kasina which embody the properties in a more complex way. This could entail, a scene where, for the fire kasina, a fiery volcanic inferno is produced or a watery scene for that particular kasina involved oceanic components, waterfalls or suchlike. For the more abstract kasina this might involve creating a 'blue', 'red' or 'yellow' space; an airy space and finally a void like space. Basically, embodying the symbolic properties of the kasina in 3D virtual space.

```
using UnityEngine;
using UnityEngine.EventSystems;
using System.Collections;

public class CursorPositioner : MonoBehaviour {
    private Camera camera;
    private float defaultPosZ;

    void Start () {
        camera = GameObject.FindWithTag ("MeCamera").GetComponent<Camera>();
        defaultPosZ = transform.localPosition.z;
    }

    void Update () {
        Ray ray = new Ray (camera.transform.position, camera.transform.rotation * Vector3.forward);
        RaycastHit hit;
        if (Physics.Raycast (ray, out hit)) {
            //Debug.Log (transform.localPosition + "D: " + hit.distance );
            if (hit.distance <= 1.0f) {
                transform.localPosition = new Vector3( 0, 0, hit.distance );
            } else {
                transform.localPosition = new Vector3( 0, 0, defaultPosZ );
            }
        }
    }
}
```

Fig. 2. Code development in Mono utilizing Raycast to determine where an individual's gaze falls

Another possibility is the adding of frequency components which induce the frequency following response discussed in the previous paper. The headset immersion offers some interesting opportunities; one of which is the ability to know where a person is looking at a given point in time. It would be possible to attach auditory streams to particular objects, or parts of objects, which are particular to some representation of that kasina. This could be a frequency entrainment audio stream, an audio track or a vocal track. It is also possible to mix the entrainment within the audio stream so it is not noticeable (using modulation techniques).

C. Mimicking the Mind Machines

To extend this idea further, we can utilise a more abstract approach which uses a visual and auditory mechanism to induce the entrainment. In a previous paper the use of 'mind machines' was documented and explored. Briefly, the commercially available mind machines such as the Procyon, Proteus and Kasina utilise light and sound for a frequency entrainment mechanism to induce particular states. They also can attempt to take the user on a journey through particular patterns, toward some purpose which may be relaxation or arousal for a purpose such as learning or meditation. In these devices, an array of LEDs is placed within glasses and headphones are worn to embed the user in a kind of proto-virtual space. The eyes are closed and a kind of Ganzfeld effect is seen upon the eyelids with myriad shapes and changing patterns which of course is synchronised to synthesised or sampled sound played at particular frequencies. It may be possible to produce a similar effect within virtual space itself with purely abstract patterns mimicking this process, complete with audio track. There is scope here for experimentation and exploring how this would effect the brain in comparison to the mind machines for instance. Unlike these devices the eyes would be open and mandala type imagery and objects could be procedurally generated or, held as tracks in memory, depending on what works best.

In the previous paper it was seen how it is possible to create a feedback loop, watching the brainwave pattern, and responding to attempts to entrain a particular, and desired, way. Again, within this particular experiment, using abstract 3D virtual space it would be possible to do this.

D. Leading with a Vocal Stream

Finally, a voice-over could be used to lead the attention. We see this particular technique in several meditation and yogic paths. This could be applied to the Kasina technique itself or the more abstract techniques mentioned here. Generally, techniques which use voice draw the attention and

focus of the individual around and through a scene. This is not unlike hypnosis techniques. In Yoga Nidra (literally, yogic sleep) there is the "rotation of consciousness" which involves, at its most fundamental, the simple bringing to attention body parts as they are mentioned which are repeated by the meditator, thereby focusing the mind and moving the awareness around the body. This technique was not explored here, although could be considered for future experiments.

IV. THE VIRTUAL MEDITATION LAB

A meditation "lab" was developed in virtual space using Unity. This consisted of components essential to the main tools of focus within the Kasina practice. A relatively simple set of requirements were developed for the first experiments:

1. A set of kasina elements including earth, water, fire, air, wind, blue, green, yellow red, white, enclosed space, hole, aperture, consciousness, bright light. All as discussed above.
2. A basic area for these to be set out in 3D virtual space
3. The ability to trigger events through focus on objects
4. Audio stream capability in-sync or at least programmable in some sense

As described above the basic disks were easily modelled and developed within Unity. The properties of each in line with attributes associated with the kasina involved.

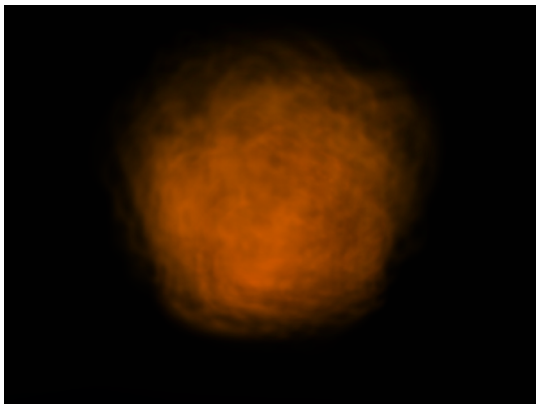

Fig. 3. The Fire Kasina

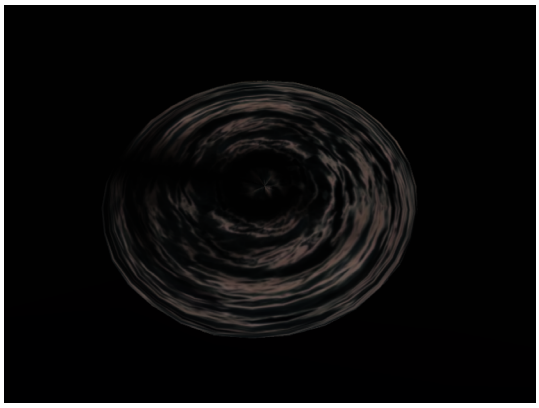

Fig. 4. The Water Kasina

A. Experiment 1: Replicating the Technique

An initial experiment involved the replication of the procedure and technique which occurs in normal space – the placing of the kasina as disks, light and elemental objects.

The space was made as simple as possible, within Unity, with little to distract. Google cardboard was targeted for the headset (though other formats were also used later). This produced a useful initial app which could be simply tapped when required. The headset itself was a commercially made holder for the android phone which was an HTC M8. No problems were encountered in the actual 3D modelling as only basic shapes were required for this particular stage, and they already existed within Unity's library (Blender software was available but not required here). Headphones were necessary for the audio track and also the EEG system which was the Bluetooth wireless Mindwave Mobile by Neurosky [16]. The resulting hardware system allows for virtual reality embedding with audio and EEG feedback which can be processed to control, modulate or attenuate any meditation tool output.

The initial disk was duplicated with the properties of the appropriate kasina. Options were available for a slight axial spin. Plain colours were produced first and initial experiments were initiated by allowing an individual meditator to sit passively while staring at the 3D object. For this first stage, data collected included how much the gaze appeared to drift away from the object, along with the EEG pattern. No audio was used initially.

B. Experiment 2: Addition of Associated Audio

Audio was introduced where it was possible to use associated sound with an object. For example, water. Here the sound of running water, oceans and waterfalls could be used. For fire, similarly the sound of burning, volcanic activity and suchlike. For the more abstract objects obviously it becomes more subjective – what sound, after all, could be associated with blue or red?

C. Experiment 3: Entrainment and Biofeedback Loop

Utilizing the kasina object and technique with entrainment offers some interesting aspects and this was relatively easy to do.

Initially a sample of an audio was made to play as the gaze was fixed on the object of focus. Later, an actual synthesis process was developed (similar to previous papers) which allows for modification in real-time to adapt as the brainwave reacts (or is unresponsive). In the case of an individual that seems resistant to the entrainment, it is possible to 'hold' a particular phase of the audio cycle. This implements a simple, but effective, biofeedback loop.

D. Experiment 4: Virtual Mind Machine

An extension of the project was the idea of implementing a purely abstract but virtual 3D version of the mind machine. This is somewhat of an aside to Kasina techniques, though the

idea behind Kasina is that some form of object is used to initiate access concentration. This could equally be an abstract 3D imagery.

Several ways were considered how this might be produced. In mind machines this is implemented by using flashing LEDs at specific frequencies in time with the audio track. And in most machines this is done through having the eyes closed and a kind of Ganzfield effect being present (a dispersed colour field over the eyes). The end result of this is a kind of mandala rich space being made present. Some of the new machines offer an eyes open experience. In 3D space, with eyes open, many options are made available, though the central idea of the optical frequency strobe should be there. This eyes open exposure to frequencies does occur naturally in real life – an example being stroboscopic experiences as trees are passed on roads and the light becomes shuttered; this has been known to induce seizures or trances at inopportune moments.

V. INITIAL FINDINGS

As in previous experiments with meditation and VR, there does seem to be interesting results which are worth exploring further in groups with controls, to allow for proper data collection. The main purpose here was to explore how the technology could be applied and implemented, though the limited results are explored and where they point to. Results were collected via the Neurosky Mobile Mindwave eSense output value for meditation [17]

An experienced and a novice meditator were used to as simple test subjects. Fig. 5 shows a "baseline" of non-aided Kasina meditation over a 35 minute period.

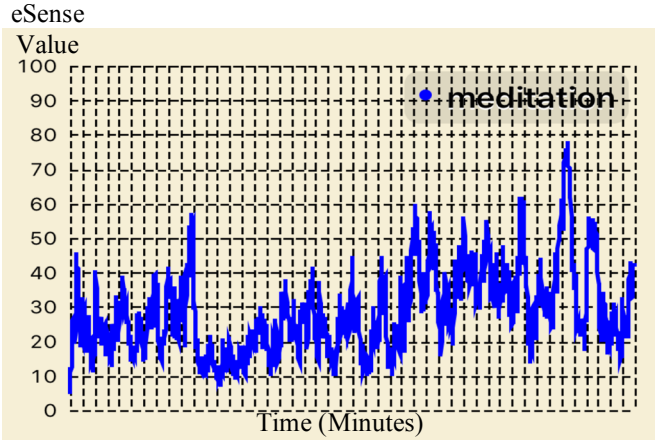

Fig. 5. Novice meditation without technological aids for 35 minute period

Experiment 1 was the duplication of Kasina meditation in VR space. Results here (see fig. 6) seemed to indicate that the encapsulation or embedding within VR of the subject helped concentration in the novice, particularly. The experienced meditator appears to find focus very quickly, which was not expected in the novice. Results from previous papers do seem to suggest that VR does tend toward helping subjects find focus quicker than would be expected.

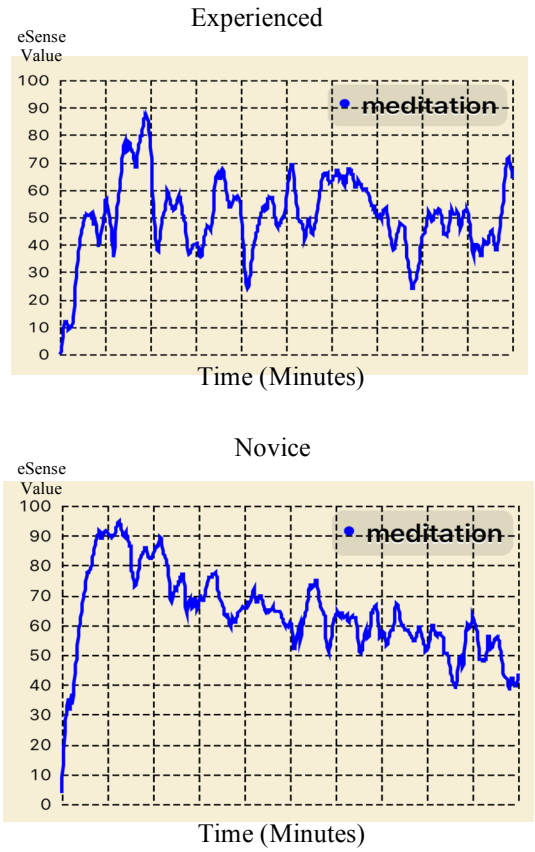

Fig. 6. VR-Kasina meditation over initial 10 minute period.

Experiment 2 was the audio (and mainly ambient sound enhancement) addition to the usual Kasina meditation. The results here seemed to indicate only a marginal difference between a purely visual stimulus and a joint visual / auditory stimulus. The difference in results may indicate that the ambient sound does help embedding the subject in the virtual environment. This seemed mainly to effect the novice.

Experiment 3 included the idea of entrainment but still had the kasina object present (see fig. 7). Using an audio stream containing an induction into alpha state seemed to again help

the novice although there is some indication that the experienced meditator was likewise effected, judging from the logged EEG. A simple sample stream was used and also, a generated stream which adapted on the basis of whether the subject had achieved a particular state at a given point. If the EEG had not reached that point then the entrainment would hold, or even backtrack, until a similar reaction was forth coming. This is effectively a biofeedback loop.

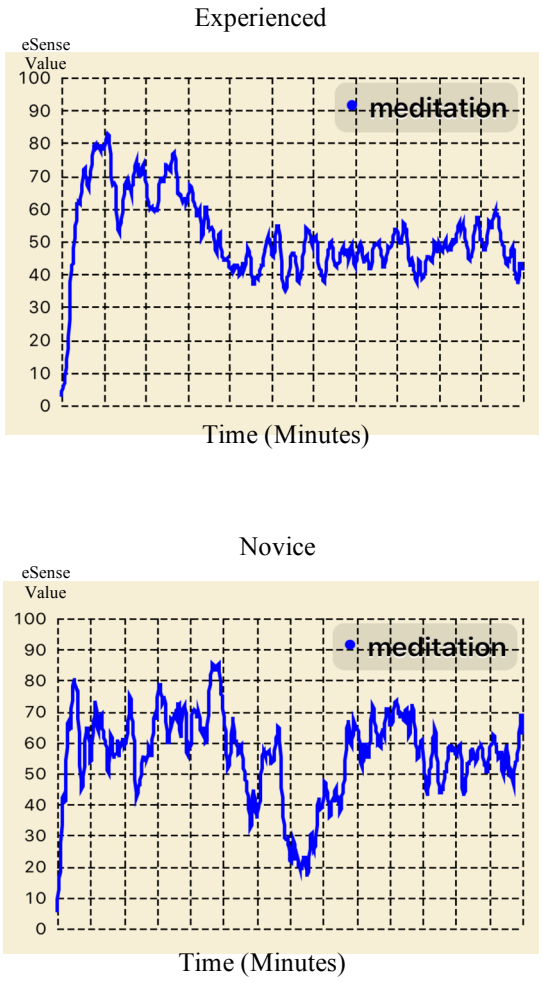

Fig. 7. Kasina meditation with entrainment for a 11 minute period. Note drop-out in concentration in novice and recuperation/restore to meditation

Experiment 4 dispensed with the usual kasina objects entirely and utilised an abstract (and similar to mind machines) approach with both visual and audio entrainment components. The subjects were unlikely to stay fixed, in concentration, to any one of these moving patterns but are likely to have a "wide focus" which is actually entering into a different meditation technique entirely (see fig. 8). It could be argued whether this is meditation or actually inducing some kind of trance.

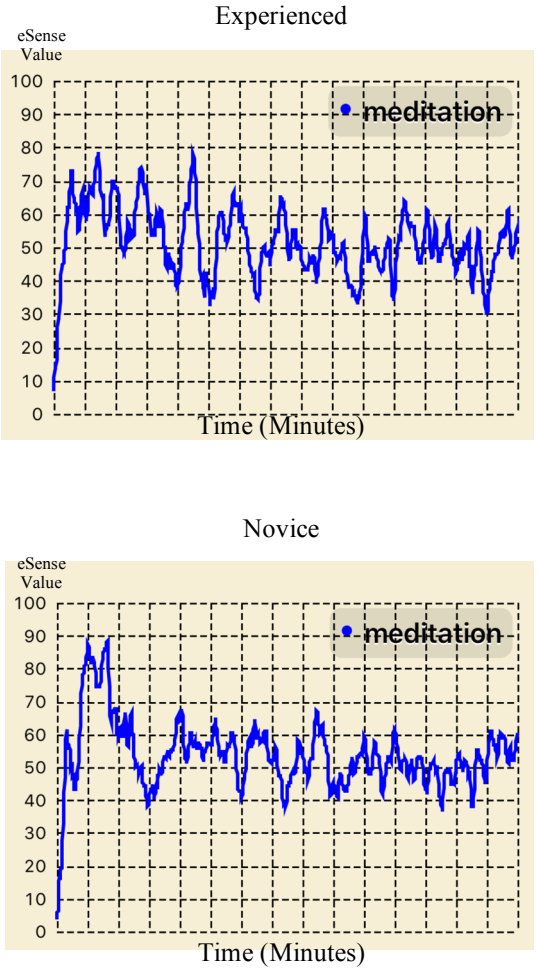

Fig. 8. VR abstract meditation sequence with entrainment.

It is early in the process of these experiments to draw any firm conclusions, many tests need to be run and more individuals should be exposed to this particular approach. Generally, though, the data collected so far, seems to show:

- There is usually a spike of concentration initially, the length of which is determined by the experience of the individual
- The use of Kasina alone in VR had a perceived beneficial effect; probably due to the immersive aspect
- Where the concentration is lost in an individual the use of VR and entrainment with a biofeedback mechanism seemed to help recover the state

- The duplication of more abstract entrainment (the mimicking of the mind machine), while seeming to induce a particular state, had a different "signature" and amplitude to more recognisable patterns.

These experiments offer some interesting insights into what could be pursued with this technology. Particularly of interest is the use of the VR Kasina technique with entrainment, controlled by biofeedback which seemed useful in novices at maintaining concentration.

As stated, there are other avenues to pursue within this area (as well, obviously, as the expansion of data collection within this one). The use of voice to lead the mind, as in Yoga Nidra, mentioned above, for example could be expanded into VR and explored further. Mindfulness and in particular the meditation technique Kasina, is proving itself to be useful in many conditions [18] and it is possible that the techniques presented here offer many enhanced avenues for development and research.

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